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EXAMINER	
LANDAU, MATTHEW C	
ART UNIT	PAPER NUMBER
2815	

DATE MAILED: 06/03/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/518,602	ANDO ET AL.	
	Examiner	Art Unit	
	Matthew Landau	2815	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *36-85* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *36-62, 64-70 and 74-85* is/are rejected.

7)☒ Claim(s) *63 and 71-73* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *04 March 2005* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *12/17/04, 3/3/05*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Drawings

Figures 1-4 should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g).

The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, the first metal layer comprising NiN or PdN must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Objections

Claims 36, 49, 62, and 74 are objected to because of the following informalities:

Regarding claim 36, the limitation "Ga_vAll_{1-v}" should be changed to "Ga_vAl_{1-v}" and the limitation "MO_xN_{1-x}" should be changed to "Mo_xN_{1-x}".

Regarding claim 62, the limitation "as a main component III-elements" should be changed to "as a main component of the Group III-elements".

Regarding claims 36, 49, 62, and 74, there is insufficient antecedent basis for "the Group III-elements" and "the Group V-elements".

Appropriate correction is required.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 74-85 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Regarding claim 74, the limitation "$Ni_{y4}N_{1-y4}$ and $Pd_{y5}N_{1-y5}$ (where, $0.5 \leq y5 \leq 0.85$)" renders the claim indefinite. Applicant has not defined any parameters for y4. For the purposes of the Office Action, it is considered that y4 can be any value between (and including) 0 and 1.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 36 is rejected under 35 U.S.C. 102(e) as being anticipated by Taniguchi et al. (US PgPub 2003/0107065, hereinafter Taniguchi).

Regarding claim 36, Figure 2d of Taniguchi discloses a semiconductor device comprising a semiconductor layer 17 using GaAl as a main component of the Group III-elements and N as a main component of the Group V-elements (paragraph [0069]) and a Schottky junction metal layer which is in contact with the semiconductor layer, wherein: said Schottky junction metal layer comprises a laminated structure wherein a first metal layer (Ni) is in contact with said semiconductor layer, a second metal layer 10 is in contact with said first metal layer, and a third metal layer 6 is in contact with the second layer; said second metal layer comprises a metal material (Mo) having a higher melting point than those of the metal materials in said first metal layer and said third metal layer (Ni and Au, respectively), said third metal layer comprises a metal material (Au) having a lower resistivity than those of the metal materials in said first metal layer and said second metal layer; said first metal layer comprises Ni; and said second metal layer comprises Mo.

Applicant cannot rely upon the foreign priority papers to overcome this rejection because a translation of said papers has not been made of record in accordance with 37 CFR 1.55. See MPEP § 201.15.

Claims 74-82 are rejected under 35 U.S.C. 102(a) as being anticipated by the admitted prior art (APA).

Regarding claims 74 and 75, as best the examiner can ascertain the claimed invention, Figure 1 of the instant application (the APA) discloses a semiconductor device comprising a semiconductor layer 64 using GaAl as a main component of the Group III-elements and N as a main component of the Group V-elements and a Schottky junction metal layer 67 which is in contact with the semiconductor layer, wherein: said Schottky junction metal layer comprises a laminated structure wherein a first metal layer 671 is in contact with said semiconductor layer and a second metal layer 672 is in contact with said first metal layer; said first metal layer comprises a metal material (Ni) having a higher melting point than that of the metal material (Au) in said second metal layer; said second metal layer having a lower resistivity than that of the metal material of said first metal layer; and said first metal layer comprises $Ni_{y4}N_{1-y4}$, where it is considered that y4=1.

Regarding 76, it is inherent that the first metal layer 671 (Ni) has a higher work function than said second metal layer 672 (Au).

Regarding claim 77, the APA discloses the first metal layer has a melting point of 1000 degrees C or higher. Note that the melting point of nickel is approximately 1453 degrees C.

Regarding claims 78 and 79, Figure 1 of the APA discloses said semiconductor layer 64 is formed on a multilayered structure comprising a plurality of compound semiconductor layers formed on a sapphire substrate 1.

Regarding claim 80, Figure 1 of the APA discloses the semiconductor layer 64 is an AlGaN layer.

Regarding claims 81 and 82, Figure 1 of the APA discloses the semiconductor layer 64 is a GaN compound semiconductor (AlGaN) electron supplying layer formed on a GaN compound semiconductor (GaN) channel layer.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 36-45 are rejected under 35 U.S.C. 103(a) as being unpatentable over the admitted prior art (APA) in view of Furukawa et al. (US Pat. 4,951,121, hereinafter Furukawa).

Regarding claims 36 and 37, Figure 1 of the instant application (the APA) discloses a semiconductor device comprising a semiconductor layer 64 using GaAl as a main component of the Group III-elements and N as a main component of the Group V-elements and a Schottky junction metal layer 67 which is in contact with the semiconductor layer, wherein: said Schottky junction metal layer comprises a laminated structure wherein a first metal layer 671 is in contact with said semiconductor layer, a third metal layer 672 is above the first metal layer; and said first

metal layer comprises Ni. The difference between the APA and the claimed invention is a metal layer (second metal layer) between the first and third layers comprising Mo. Figure 1 of Furukawa discloses a Schottky electrode on a III-V semiconductor layer 5, wherein the electrode comprises first, second, and third metal layers. The second metal layer 3 comprises Mo, and the third metal layer 2 comprises gold (col. 3, lines 40-50). In view of such teaching, it would have been obvious to the ordinary artisan at the time the invention was made to further modify the invention of the APA by including an Mo layer between the first layer 671 and the third layer 672 for the purpose of reducing the unwanted penetration of gold through the high melting metal layer into the substrate (col. 2, lines 44-47 of Furukawa). Further note that said second metal layer comprises a metal material (Mo) having a higher melting point than those of the metal materials in said first metal layer (Ni) and said third metal layer (Au), and said third metal layer comprises a metal material (Au) having a lower resistivity than those materials in said first metal layer and said second metal layer.

Regarding claims 38 and 39, in the above combination, the first metal layer comprises a material (Ni) that inherently has a higher work function than that of the metal materials in the second and third layers (Mo and Au, respectively).

Regarding claim 40, in the above combination, the material of the second metal layer is Mo. Mo has a melting point of approximately 2600 degrees C.

Regarding claims 41 and 42, Figure 1 of the APA discloses said semiconductor layer 64 is formed on a multilayered structure comprising a plurality of compound semiconductor layers formed on a sapphire substrate 1.

Regarding claim 43, Figure 1 of the APA discloses the semiconductor layer 64 is an AlGaN layer.

Regarding claims 44 and 45, Figure 1 of the APA discloses the semiconductor layer 64 is a GaN compound semiconductor (AlGaN) electron supplying layer formed on a GaN compound semiconductor (GaN) channel layer.

Claims 36, 46-48, 49, and 59-61 are rejected under 35 U.S.C. 103(a) as being unpatentable over Teraguchi et al. (US Pat. 6,521,998, hereinafter Teraguchi) in view of Nishii et al. (US PgPub 2003/0109088, hereinafter Nishii) and Furukawa.

Regarding claims 36, 37, 49, and 50, Figure 9 of Teraguchi discloses a semiconductor device comprising a semiconductor layer 106 using Ga as a main component of the Group III-elements and N as a main component of the Group V-elements and a Schottky junction metal layer 108 (third metal layer). Note that Teraguchi discloses the third metal layer 108 is made of gold (col. 1, lines 30-34). The difference between Teraguchi and the claimed invention is a first and a second metal layer between the third metal layer 108 and the semiconductor layer 106, the first layer in contact with the semiconductor layer and the second layer in contact with the first layer, wherein the first layer comprises PdSi and the second layer comprises Mo. Figure 1 of Nishii discloses a Schottky junction metal layer 6 over a GaN semiconductor layer 4, wherein the metal layer 6 comprises $Pd_{z3}Si_{1-z3}$ (z3=.2) (paragraph [0063]). In view of such teaching, it would have been obvious to the ordinary artisan at the time the invention was made to modify the invention of the Teraguchi by using PdSi with the above stoichiometry for the purpose of reducing electrode peeling (paragraph [0051]) while maintaining good Schottky characteristics

(paragraph [0063]). Furthermore, Figure 1 of Furukawa discloses a Schottky electrode on a III-V semiconductor layer 5, wherein the electrode comprises first, second, and third metal layers. The second metal layer 3 comprises Mo, and the third metal layer 2 comprises gold (col. 3, lines 40-50). In view of such teaching, it would have been obvious to the ordinary artisan at the time the invention was made to further modify the invention of the Teraguchi by including an Mo layer between the first layer and the third layer 108 for the purpose of reducing the unwanted penetration of gold through the high melting metal layer into the substrate (col. 2, lines 44-47 of Furukawa). Further note that said second metal layer comprises a metal material (Mo) having a higher melting point than those of the metal materials in said first metal layer (PdSi) and said third metal layer (Au), and said third metal layer comprises a metal material (Au) having a lower resistivity than those materials in said first metal layer and said second metal layer.

Regarding claims 46, 47, 59, and 60, Figure 9 of Teraguchi discloses said semiconductor layer 106 is a GaN compound semiconductor channel layer comprising GaN formed on a GaN compound semiconductor electron supplying layer (doped layer) comprising AlGaN.

Regarding claims 48 and 61, Figure 9 of Teraguchi discloses said semiconductor layer 106 is a n-type GaN channel layer. Note that Teraguchi discloses metal layer 108 forms a Schottky junction (col. 1, lines 26-28), and that a Schottky junction is formed only when using n-type semiconductors (col. 1, lines 35-38). Therefore, layer 106 is n-type.

Claims 49-58 are rejected under 35 U.S.C. 103(a) as being unpatentable over the APA in view of Nishii and Furukawa.

Regarding claims 49 and 50, Figure 1 of the instant application (the APA) discloses a semiconductor device comprising a semiconductor layer 64 using GaAl as a main component of the Group III-elements and N as a main component of the Group V-elements and a Schottky junction metal layer 67 which is in contact with the semiconductor layer, wherein: said Schottky junction metal layer comprises a laminated structure wherein a first metal layer 671 is in contact with said semiconductor layer, a third metal layer 672 is above the first metal layer. The difference between the APA and the claimed invention is said first metal layer comprises $Pd_{z3}Si_{1-z3}$ (where, $0.5 \leq z3 \leq 0.85$). Figure 1 of Nishii discloses a Schottky junction metal layer 6 over a GaN semiconductor layer 4, wherein the metal layer 6 comprises $Pd_{z3}Si_{1-z3}$ (z3=.2) (paragraph [0063]). Also note that the APA discloses layer 671 can be made of Pd (page 2, lines 8-10 of the instant specification). In view of such teaching, it would have been obvious to the ordinary artisan at the time the invention was made to modify the invention of the APA by using PdSi with the above stoichiometry for the purpose of reducing electrode peeling (paragraph [0051]) while maintaining good Schottky characteristics (paragraph [0063]). A further difference between the APA and the claimed invention is a metal layer (second metal layer) between the first and third layers comprising Mo. Figure 1 of Furukawa discloses a Schottky electrode on a III-V semiconductor layer 5, wherein the electrode comprises first, second, and third metal layers. The second metal layer 3 comprises Mo, and the third metal layer 2 comprises gold (col. 3, lines 40-50). In view of such teaching, it would have been obvious to the ordinary artisan at the time the invention was made to further modify the invention of the APA by including an Mo layer between the first layer 671 and the third layer 672 for the purpose of reducing the unwanted penetration of gold through the high melting metal layer into the substrate (col. 2, lines 44-47 of

Furukawa). Further note that said second metal layer comprises a metal material (Mo) having a higher melting point than those of the metal materials in said first metal layer (PdSi) and said third metal layer (Au), and said third metal layer comprises a metal material (Au) having a lower resistivity than those materials in said first metal layer and said second metal layer.

Regarding claims 51 and 52, in the above combination, the first metal layer comprises a material (PdSi) that inherently has a higher work function than that of the metal materials in the second and third layers (Mo and Au, respectively).

Regarding claim 53, in the above combination, the material of the second metal layer is Mo. Mo has a melting point of approximately 2600 degrees C.

Regarding claims 54 and 55, Figure 1 of the APA discloses said semiconductor layer 64 is formed on a multilayered structure comprising a plurality of compound semiconductor layers formed on a sapphire substrate 1.

Regarding claim 56, Figure 1 of the APA discloses the semiconductor layer 64 is an AlGaN layer.

Regarding claims 57 and 58, Figure 1 of the APA discloses the semiconductor layer 64 is a GaN compound semiconductor (AlGaN) electron supplying layer formed on a GaN compound semiconductor (GaN) channel layer.

Claims 62 and 64-70 are rejected under 35 U.S.C. 103(a) as being unpatentable over the APA in view of Kim et al. ("High-temperature structural...", hereinafter Kim).

Regarding claim 62, Figure 1 of the instant application (the APA) discloses a semiconductor device comprising a semiconductor layer 64 using GaAl as a main component of

the Group III-elements and N as a main component of the Group V-elements and a Schottky junction metal layer 67 which is in contact with the semiconductor layer, wherein: said Schottky junction metal layer comprises a second metal layer 671. The difference between the APA and the claimed invention a first metal layer comprising NiN between the second metal layer and the semiconductor layer. Kim discloses an electrode on a GaN layer, wherein the electrode is a multilayer film comprising NiN/Ni/Au (see abstract). In view of such teaching, it would have been obvious to the ordinary artisan at the time the invention was made to modify the invention of the APA by including a NiN layer between the Ni layer 671 and the semiconductor layer for the purpose of improving device reliability by reducing dislocations (see abstract of Kim). Note that in the above combination, the NiN layer can be considered the first metal layer, and the Ni layer 671 can be considered the second metal layer. Therefore, it is inherent that the first metal layer (NiN) has a higher melting point and a higher resistivity than the second metal layer (Ni).

Regarding 64, it is inherent that the first metal layer (NiN) has a higher work function than said second metal layer 671 (Ni).

Regarding claim 65, it is inherent that the first metal layer (NiN) has a melting point of 1000 degrees C or higher.

Regarding claims 66 and 67, Figure 1 of the APA discloses said semiconductor layer 64 is formed on a multilayered structure comprising a plurality of compound semiconductor layers formed on a sapphire substrate 1.

Regarding claim 68, Figure 1 of the APA discloses the semiconductor layer 64 is an AlGaN layer.

Regarding claims 69 and 70, Figure 1 of the APA discloses the semiconductor layer 64 is a GaN compound semiconductor (AlGaN) electron supplying layer formed on a GaN compound semiconductor (GaN) channel layer.

Claims 74 and 83-85 are rejected under 35 U.S.C. 103(a) as being unpatentable over Teraguchi in view of the APA.

Regarding claim 74, as best the examiner can ascertain, Figure 9 of Teraguchi discloses a semiconductor device comprising a semiconductor layer 106 using Ga as a main component of the Group III-elements and N as a main component of the Group V-elements and a Schottky junction metal layer 108 (second metal layer). Note that Teraguchi discloses the second metal layer 108 is made of gold (col. 1, lines 30-34). The difference between Teraguchi and the claimed invention is a first metal layer between the semiconductor layer and the second metal layer, wherein the first metal layer comprises $Ni_{y4}N_{1-y4}$ (y4=1). Figure 1 of the APA discloses a first metal layer 671 (Ni) between a semiconductor layer 64 and a second metal layer 672 (Au). In view of such teaching, it would have been obvious to the ordinary artisan at the time the invention was made to modify the invention of Teraguchi by including a nickel layer between the gold layer 108 and the semiconductor layer 106. The ordinary artisan would have been motivated to modify Teraguchi in the manner described above for the purpose of improving the Schottky junction by using a metal with a higher workfunction (Ni) in contact with the semiconductor, while maintaining the low electrical resistance provided by the gold layer (page 2, lines 1-11 of the instant specification). Note that nickel has a higher melting point and a higher resistivity than gold.

Regarding claims 83 and 84, Figure 9 of Teraguchi discloses said semiconductor layer 106 is a GaN compound semiconductor channel layer comprising GaN formed on a GaN compound semiconductor electron supplying layer (doped layer) comprising AlGaN.

Regarding claim 85, Figure 9 of Teraguchi discloses said semiconductor layer 106 is an n-type GaN channel layer. Note that Teraguchi discloses metal layer 108 forms a Schottky junction (col. 1, lines 26-28), and that a Schottky junction is formed only when using n-type semiconductors (col. 1, lines 35-38). Therefore, layer 106 is n-type.

Allowable Subject Matter

Claims 63 and 71-73 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew C. Landau whose telephone number is (571) 272-1731.

The examiner can normally be reached from 8:30 AM - 5:30 PM. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on (571) 272-1664. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9306 for regular communications and (703) 872-9306 for After Final communications.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should any questions arise regarding access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Matthew C. Landau

Examiner

May 25, 2005

TOM THOMAS
SUPERVISORY PATENT EXAMINER